

The Fossil Cypraeidae of the Buckingham Member (Unit 10), Tamiami Formation of Southern Florida: (Mollusca: Gastropoda: Cypraeidae)

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ABSTRACT The oldest recorded fossil Cypraeidae from southern Florida date from the late Zanclean-early Piacenzian Pliocene (circa 3.8-3.6 million years ago - hereinafter “mya”) in the Myakka Lagoon System, a shallow water estuary that lies beneath the present day Sarasota area. Shallow water sea grass beds and nascent shoreline mangrove forests hosted seven Cypraeidae species in five genera. Determining the origins of these species is challenging as only steinkern casts have been found in adjacent lower layers. However, enough features are present in two of the casts to infer the ancestral presence of two of the genera. For the other genera and species, a comparison of features with the northern Florida Panhandle Cypraeidae populations dating from the Burgdigalian Miocene (16-20 mya) does suggest certain affinities. However, no direct lineage can be asserted with any confidence. The sea bed deposit layer of this period has been designated the Buckingham Member of the Tamiami Formation of southern Florida.

KEYWORDS Duplinian Subprovince, Buckinghamian Subprovince, Tamiami Formation, Buckingham Member, Cypraeidae, fossil, *Akleistostoma*, *Siphocypraea*, *Pahayokea*, *Calusacypraea*, *Pseudadusta*, Myakka Lagoon System, Sarasota area, Polk Peninsula, Kissimmee Embayment, Kissimmee River Valley, St. Lucie Peninsula.

INTRODUCTION

“The Cypraeidae of Plio-Pleistocene southern Florida produced the single largest radiation of cowrie shells, known from one locality, ever found on Earth. ... [T]he cowrie fauna of the Everglades and adjacent areas represented ... 104 species, making it one of the largest groups of macrogastropods found in late Neogene southern Florida.” (quote from the Introduction to *Jewels of the Everglades, The Fossil Cowries of Southern Florida*, 2018, by Edward J. Petuch *et al.*). This book is a comprehensive presentation of these cowrie species presented by genus and subgenus, rather than by their place in geologic time. By time sequence, the species radiation began with the Buckingham Member (Unit 10) of the Tamiami Formation (circa 3.8-3.6 mya). This paper examines the

commencement of the cowrie species radiation during this period of time. This also marks the beginning of successive disappearances and emergences of new cowrie species confined to their individual formations and members through to the latest Pleistocene (12,000 years ago (hereinafter “kya”).)

Peninsular Florida.

Before the Miocene (24 mya), peninsular Florida did not exist. Thirty-two mya, a small, shallow carbonate bank had developed on the underlying bedrock Florida Platform (a rampart between the Gulf of Mexico and the Atlantic Ocean). It lies over 150 km off the coast of Georgia, in what is now the northern part of peninsular Florida, and was separated from the mainland by a wide shallow seaway (Suwannee

Strait). The bank was the highest point of six thick (2-6 km), carbonate formations that had developed on the platform prior to the Miocene. As the Miocene approached, erosion of carbonate areas to the north flowed to the south and allowed the bank to become an island (Orange Island). Ultimately, this, combined with the growth of coral reef systems around the island, led to the closure of the Suwannee Strait and the merger with the mainland in the early Miocene. By 18 mya, peninsular Florida remained emergent despite a period of high sea levels. At the time, the future Everglades would have been a small area on the southeast of the Florida Platform. The platform and these formations still underlie peninsular Florida today.

Initially, peninsular Florida only covered the northern area of the peninsula with its peripheral areas being filled in over time. By mid-Pliocene (3.8-3.6 mya), the northern area had filled out to a great extent. However, the Polk Peninsula in the center of present day peninsular Florida and the St. Lucie Peninsula on the eastern coast constituted its southern edge. In the present day Sarasota area on the

western side of the Polk Peninsula, there existed a shallow, estuarine lagoon fed by the Myakka River. In the present day Kissimmee River Valley, between the two peninsulas, there was a long, shallow embayment.

Geological Framework.

Just what and where are the Buckingham Member and the Tamiami Formation of south Florida? To understand these geological concepts, it is necessary to start from a higher view and work down from there. Geologists have divided the world into geologic provinces which are defined as “any large area or region considered as a whole, all parts of which are characterized by similar features or by a history differing significantly from that of adjacent areas” (Glossary of Geology, 1980). The U.S. Geological Survey, last updated in the mid 2000s, designated the region from Cape Cod to the Mexican border and then to the Yucatan Peninsula as the Atlantic Plain Province. In the present day, it is the flattest of the American provinces, sloping gently seaward in a series of terraces far into the Atlantic and Gulf of Mexico where it forms the continental shelf.

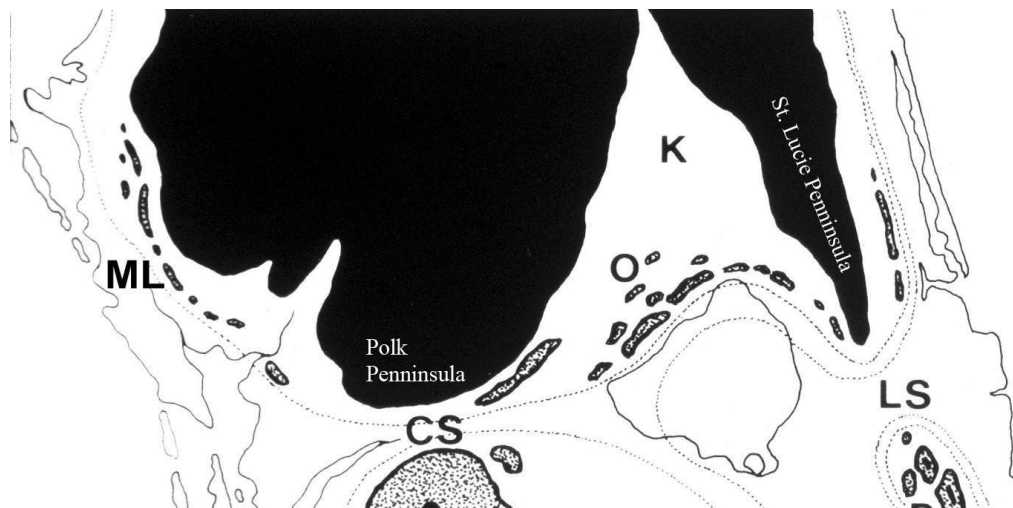


Figure 1. Map reflecting the Tamiami Subsea. ML = Myakka Lagoon System; K = Kissimmee Embayment; O = Okeechobee Patch Reefs; CS = Caloosahatchee Strait; LS = Loxahatchee Strait. Adapted from Petuch *et al.* 2018, figure 1.5 at p. 37.

The Atlantic Plain Province of today covers an immense area. However, during previous epochs, land formations and coast lines did not conform to the present day. For the latest Pliocene-earliest Pleistocene, Petuch (2004) proposed the Paleo Caloosahatchian Province, which extended from Nova Scotia, around Florida and into the Gulf of Mexico as far as Texas. In addition, four subprovinces were proposed, but only two are relevant to this paper: the Duplinian Subprovince of North Carolina and the Buckinghamian Subprovince of southern Florida. The former extended south to the northern edges of the Buckinghamian and can be considered a shared overlap zone, having shared many genera and species with its southern neighbor. The latter extended as far north as Tampa in the west and Cape Canaveral in the east.

Within subprovinces, geologists have recognized formations which may also have members. Formations consist of distinct strata in a geological region that have comparable visible features which distinguish the strata from all other adjacent formations. Together, two or more sequential formations can form a group, the formations of which also share certain features. In south Florida, the Okeechobee Group consists of eight formations, dating from the mid-Pliocene (cir. 3.8-3.6 mya) to the latest Pleistocene (12 kya). The oldest, the Tamiami Formation (Tamiami) of Southern Florida spanned the late Pliocene and contained five members.

The Tamiami Formation (named after the Tamiami Trail between Naples and Miami) underlies the entire Everglades region. There are no natural surface outcroppings within the formation, rather the strata (beds) consist of clays in limited quantities confined to shorelines and estuaries, quartz and limestone sand in beds

as well as intermixed with bioclasts, mostly mollusks and corals.

Within a formation, members represent part of a formation but distinct strata within the formation. Within the Tamiami Formation, the members (strata) represent separate and different depositional sea beds that were deposited as the result of sea level and climate changes over time. The Buckingham Member (named after the town of Buckingham on the Caloosahatchee River) also underlies the entire Everglades region with the exception of the area around Tampa. However, only the areas around the shallow, estuarine Myakka Lagoon System, present day Sarasota area, and the Kissimmee Embayment, present day Kissimmee River Valley, are relevant to this paper. The former contained the only Cypraeidae recorded in the Buckingham while the two combined served as the areas of the next Cypraeidae radiation.

The Pliocene of Southern Florida (Buckingham Time).

Scientists use the geological time scale to describe the timing of events that have shaped the history of the earth. Based on the study of the earth's strata, they have divided the earth's history into successive time periods. For our purposes, the Pliocene Epoch (5.3 to 2.6 mya), which followed the Miocene Epoch (23.0 mya to 5.3 mya), is the most relevant to this paper. In Florida, during a crossover period between the late early Pliocene (Zanclean) and the early late Pliocene (Piacenzian) 3.8-3.6 mya, Buckingham time, the sea environments were subject to the colder water conditions which were also experienced in the Duplinian Subprovince. The growth and development of tropical marine fauna was stunted during this period. This was followed by a warming trend that began circa 3.6 mya and intensified to such an extent that it produced tropical conditions, including

extensive coral reef systems south of the Myakka Lagoon System and Kissimmee Embayment. However, we are getting ahead of ourselves.

Tamiami Formation and Members.

The Tamiami Formation was deposited in the latter part of the Pliocene from circa 3.8 to 2.58 mya and represents the thickest and richest shell fossil beds in southern Florida. As there are no natural outcroppings in the formation, particularly in the Sarasota area and Kissimmee Valley, the only access to collecting sites is through quarries, canal digs and construction sites.

In 1982, in the APAC pit at Sarasota, Florida, a deep quarry cut exposed a wall with clearly defined strata. These strata provided the basis for Petuch to assign unit numbers to the strata within the formations. The strata represent successive sea beds, one on top of the other. Subsequent studies of the quarries in the Kissimmee Embayment led to the assignment of equivalent unit numbers in that location. The unit numbers run from 11 to 0, with the higher the number the older the strata. The Buckingham Member (Unit 10) was the oldest unit to contain recorded Cypraeidae species.

NOTE: In a formation, Equivalent Members may also be designated to differentiate other distinct areas which exhibit marine fauna similar to the member. Members and their Member equivalents together represent geologic time markers, allowing geologists to date strata.

The Buckingham's best and largest exposures were in the Sarasota APAC and Quality Aggregates Pits and consisted of quartz/lime sand and mud with closely packed mollusk bioclasts intermixed. The four meters thick

exposures indicate a relatively long lived depositional period. The Buckingham extended into the Kissimmee Embayment where similar exposures were found in its upper reaches. However, in its lower reaches, sediments have been leached leaving only riverine stones/rocks intermixed with broken mollusk fragments. No Buckingham fossil Cypraeidae have been recorded from the Kissimmee Embayment.

Myakka Lagoon System / Kissimmee Embayment.

Named after and fed by the Myakka River, the Myakka Lagoon System was a tropical estuarine habitat, enclosed behind a string of near offshore fringing reefs. It stretched along the southwest coast of the incipient Polk Peninsula in the present day Sarasota area. It consisted of sand and sea grass flats and intertidal mud flats, sections of which fronted mangrove tree forests. The latter were to become common by the beginning of the early Pleistocene (2.6 mya). The intertidal flats were covered by extensive sea grass beds. In its totality, it is known today as the Myakka Lagoon System.

The Kissimmee Embayment was enclosed between the Polk and St. Lucie Peninsulas and behind the Okeechobee Reefs that formed a concave assemblage at the southern mouth of the embayment. It was far larger and more extensive than the Myakka Lagoon System, but its habitat was similar, *i.e.* sea grass beds, intertidal mud flats and mangrove tree forests. Sediments from the Kissimmee River and surrounding land areas eventually entirely filled the embayment, leaving low flatlands north of present day Lake Okeechobee in the Kissimmee River Valley.

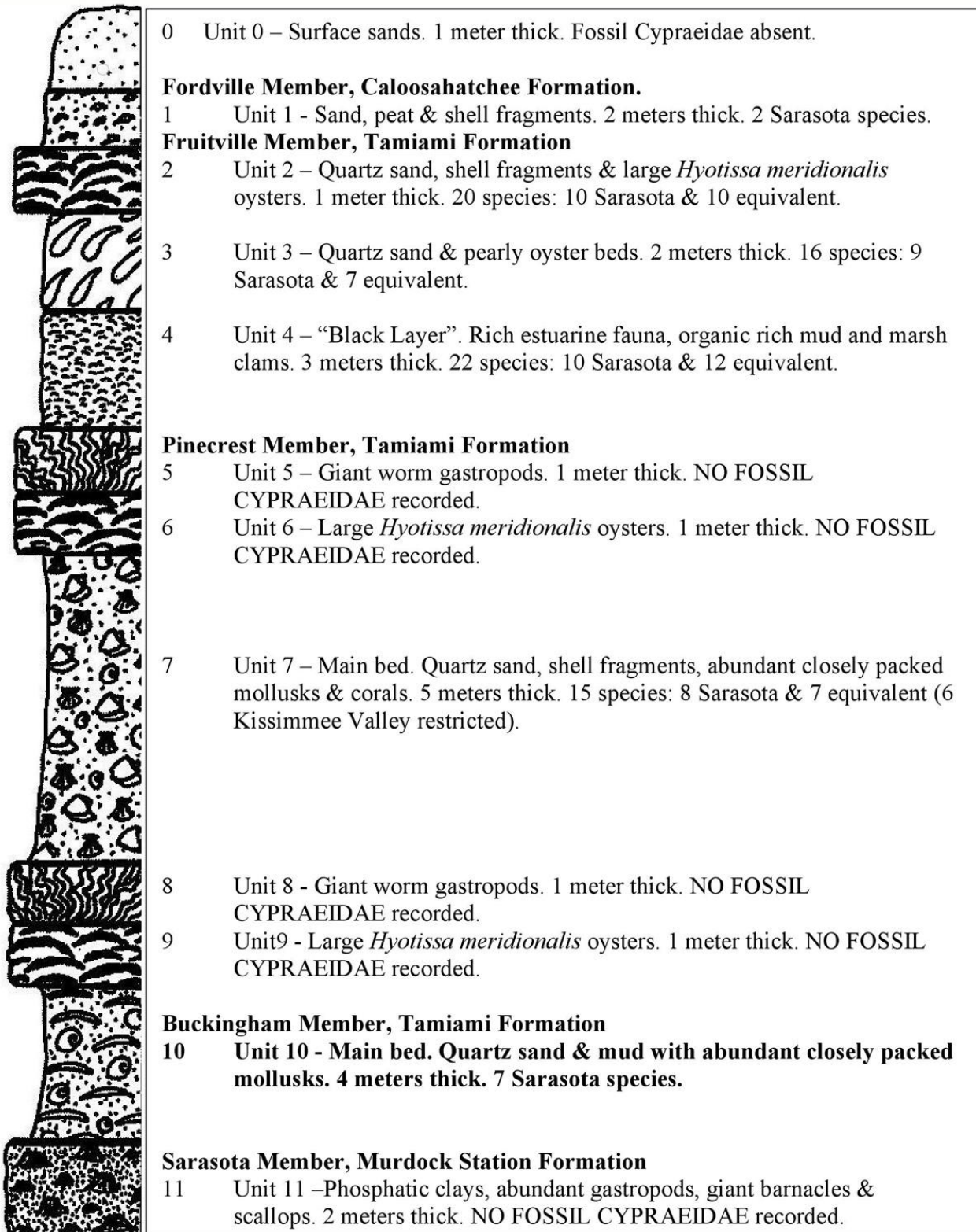


Figure 2. APAC Pit Stratigraphic Column. Adapted from Petuch & Roberts, 2007, figure 4.3 at p. 73.

Buckingham Member Species.

The seven Buckingham Member (Unit 10) species in five genera shown in Figure 3 are:

Akleistostoma carolinensis (Conrad, 1841)

Akleistostoma (Mansfieldicypraea) crocodila (Petuch, 1994)

Akleistostoma (Ingramicypraea) pilsbryi (Ingram, 1939)

Siphocypraea (Seminolecypraea) micanopy Petuch and Drolshagen, 2011

Pahayokea (Gardnericypraea) erici (Petuch, 1998)

Calusacypraea duerri (Petuch, 1996)

Pseudadusta buckinghamensis Petuch and Drolshagen, 2011

For detailed genera and species descriptions, background information and discussion, see *Jewels of the Everglades, The Fossil Cowries of Southern Florida, 2018*, by Edward J. Petuch, David P. Berschauer and Robert F. Myers.

All seven of the known Buckingham Member Cypraeidae lived in the Myakka Lagoon System. No Cypraeidae species have been recorded from the Buckingham of the Kissimmee Embayment. However, their presence may be inferred given their subsequent emergence in the Kissimmee Embayment during the succeeding Pinecrest Member of the Tamiami Formation, in the early Late Pliocene.

Habitat.

Sea grass beds constituted the most common and widespread habitat for Cypraeidae not associated with coralline habitats in both the Pliocene and Pleistocene. This is true of the Buckingham as well, although the beds were probably not as extensive as in subsequent Members. The strata suggest a quartz sand substrate in a quiet, shallow water environment.

In addition to the sea grass beds, infaunal (fauna that live in the substrate of a soft sea bottom) bivalves as well as oysters were interspersed among large clumps of barnacles, forming separate beds.

Recent Turtle Grass beds support rich faunas of bivalves and gastropods, most of which are restricted to these beds. This suggests that Buckingham Cypraeidae were also dependent upon such beds for their continued survival. The *Calusacypraea* (Petuch, 2004) genera were apparently associated with the mangrove associated mud flats of the Lagoon System.

Origins.

In the Dupilinian Subprovince, *A. carolinensis* (Figure 3 A & B) has been found in Virginia, the Carolinas and Florida's western Panhandle, while *A. (I.) pilsbryi* (Figure 3 D) has been found along the Cape Fear River in North Carolina along with *A. carolinensis*. Both were contemporaneous with the Buckingham Member. These two species, coupled other Dupilinian species, demonstrate that the molluscan fauna of that subprovince extended south into the Myakka Lagoon System and the Kissimmee Embayment, but no further south.

Again to the north but further back in time, Cypraeidae species have been collected from the Burgdigalian Miocene (late early Miocene, 16-20 mya) of the Chipola Formation in northern Florida Panhandle. However, it is not possible to designate any of these as predecessor species. While the features of the Chipola Cypraeidae suggest certain affinities with the Buckingham Member species, no direct line can be asserted with any confidence.

Farther south, the Middle Miocene Peace River Formations of DeSoto and Charlotte Counties contain only molds and casts as its sediments

are heavily leached by infiltrating ground water. However, two casts (steinkern) were collected at a mine in southwest Polk County, northeast of Sarasota. One cast was described as *Akleistostoma ductor* (Petuch and Drolshagen, 2011) and the second *Calusacypraea polkensis* (Petuch and Drolshagen, 2011). While the former cast was poorly preserved, there were enough inferred features to place it in the *Akleistostoma* Gardner, 1948 genus. It is closest to *A. carolinensis*. The *C. polkensis* cast was also poorly preserved, but there were enough inferred features to place it in the *Calusacypraea* genus, despite a narrower aperture and a less projecting posterior edge on the outer lip. It is probable that there were other ancestors, but that is an unknown at this point.

ACKNOWLEDGEMENTS

This article is based on the related collective works of Dr. Edward J. Petuch which encapsulate his 45 years of field and academic work with the geology, paleogeography and the fossil molluscan fauna of Florida.

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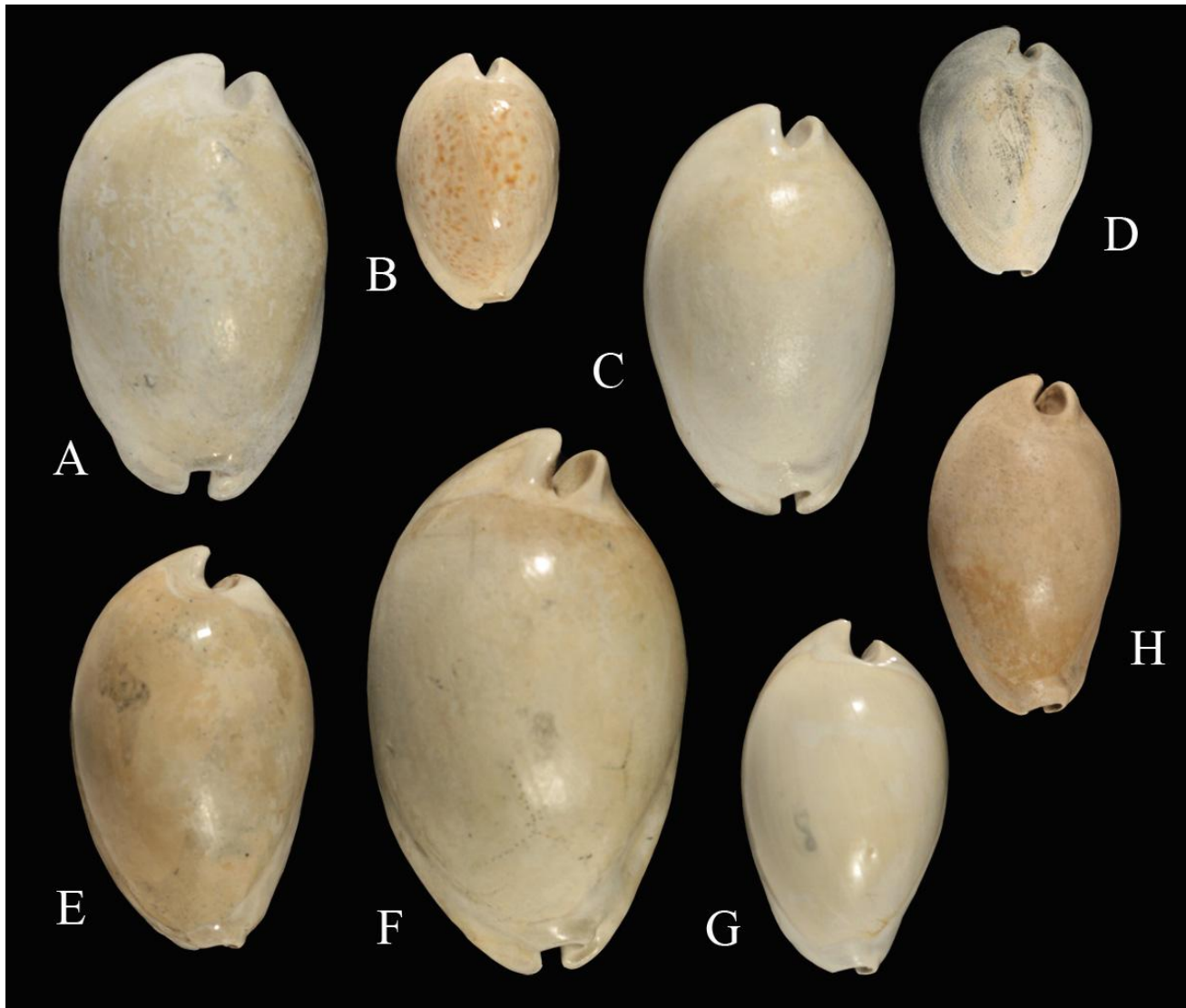


Figure 3. Fossil cowries of the Buckingham Member (Unit 10). A & B = *Akleistostoma carolinensis* (Conrad, 1841); C = *Akleistostoma (Mansfieldicypraea) crocodila* (Petuch, 1994); D = *Akleistostoma (Ingramicypraea) pilsbryi* (Ingram, 1939); E = *Calusacypraea duerri* (Petuch, 1996); F = *Pahayokea (Gardnericypraea) erici* (Petuch, 1998); G = *Pseudadusta buckinghamensis* Petuch and Drolshagen, 2011; H = *Siphocypraea (Seminolecypraea) micanopy* Petuch and Drolshagen, 2011.